World Applied Sciences Journal 15 (10): 1409-1413, 2011
ISSN 1818-4952

Forest Classification Using IRS Satellite Data

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Abstract: Forest Canopy density is an important factor in evaluation of forest status. Estimation of density is an essential part of forest inventories. Remote sensing methods assess the forest status based on quantitative and qualitative data analysis derived from “training areas”. In this study, IRS-P6, LISS III data from Galoochar Juniper forest reservoir in Iran, were analyzed to investigate the potential of this sensor for density coverage map. At first, the bands were controlled according to radiometric and geometric errors. No radiometric distortion was found. Geometric corrections were performed by 18 ground control points with digital elevation model, up to orthorectification level with precision of less than half pixel (0.35 pixel). To reduce the soil reflectance, suitable vegetation indices were prepared using soil line parameters. Ground truth map was prepared through sampling in 17% of whole area. Ground truth map was used in order to evaluate the correct conclusion of classification of image. In this research supervised classification was accomplished utilizing Maximum Likelihood, Minimum Distance to Means and Parallelepiped classifiers. Density classification was performed considering four density classes consisting of thin, semi-dense, dense and full dense coverage. In this way, Maximum Likelihood classifier presented the overall accuracy and kappa coefficient equal to 80.41 and 0.7251 respectively.

Key words: LISS III · Juniperus excelsa · Overall accuracy · Kappa coefficient · Density classification

INTRODUCTION

Natural resources, especially ranges and forests are known as dynamic ecosystems and they change as time passes. Therefore, having accurate, precise and update data in short periods, is necessary for managing in local and national scales. Because of a wide and unique view in satellite data, including most parts of electromagnetic spectrum and their update images they are suitable for producing Land use maps [1]. In order to manage the vegetation, it is necessary to assess its situation at different periods. One of the ways for this purpose is using satellite data. Perhaps the broadest use of remote sensing has been to identify and to map vegetation types [2]. Forest canopy cover is defined as the proportion of the forest floor covered by the vertical projection of the plantation crowns [3]. By measuring density in different interval we can decide better about forest managing. Estimation of density is an important part of forest inventories. The industrial activities in all over the world reduce the number of trees and canopy closure in the natural jungles. Today several satellites in the air or space with multispectral or hyper spectral sensors are able to measure the electromagnetic radiation reflected or emitted from any things like vegetation. The collected data are used to expoit the large-scale spatial-temporal distribution of vegetation and estimate its biochemical (e.g. content of chlorophyll) and biophysical (e.g. leaf area index or foliage clumping) properties [4, 5]. By using suitable mathematical operations on data we can diagnose or classify different objects. Some parameters can serve as markers of dominant plant species [6]. Space-borne remote sensing has played a pivotal role in generating suitable data about forest cover; vegetation type and land use changes [7]. For better management of forest, changes of density should be considered. Forest canopy density is one of the most important parameters to consider in the planning and implementation of rehabilitation projects. It is possible that there isn’t any change in the area of forest during the time but the density of forest

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canopy is changed. Different conventional remote sensing methods such as slicing, image arithmetic, segmentation and multispectral image classification are used by different scientists. Classification is based on quantitative and qualitative analysis of information derived from “training areas” (i.e ground trusting or verification). However, this has certain disadvantages in terms of time and cost requirements for training area establishment.

Forest land cover information is often derived from remotely sensed images using classification algorithms [8, 9]. Many of that require a substantial amount of reference data [10]. Reliable reference data is also necessary for assessing classification results.

Approaches to map forest canopy density, produced categorical maps with two [11] or more classes [12]. In the best way Canopy density should be treated as a continuous rather than discrete variable. Although using remote sensing technology has a lot of benefits, but it has some limitations. Development of more accurate remote sensing methods, supported by laboratory and field measurements of vegetation reflectance and fluorescence, could minimize these discrepancies [13]. The aim of this study is to examine ability of digital data of LISS III sensor for estimating forest canopy cover.

Study Area: In this research, Juniper forest Reservoir that is located in Kerman province (South-east of Iran), was selected. This area is between latitude 29°18' to 29°17' N and longitude of 56°07' to 56°04' E. The climate is cold and it is characterized by 400 mm/y rainfall and equable temperature.

MATERIALS AND METHODS

In this study, IRS-P6, LISS III satellite data from Galoochar Juniper forest reservoir in Kerman province, dating April 2008, were analyzed to investigate the potential of Liss Ш sensor for producing vegetation density classification map. At first, the quality of the image was evaluated. The image bands were controlled for radiometric and geometric errors. No radiometric distortion was found. Geometric corrections were performed by 18 ground control points with digital elevation model, used Toutin model for orthorectification [14] up to orthorectification level with precision of less than half a pixel (0.35 pixel). The supervised classification was performed by using basic and synthetic bands to four classes. A ground truth map was prepared through sampling in 17% of the whole area. Different synthetic bands were obtained and were used for analyzing and evaluation. To reduce the soil reflectance, suitable vegetation indices were prepared using soil line parameters [15]. Using digital topography data; the aspect, slope and elevation layers were created in geographic information system environment then these layers were overlaid and a land form map was prepared. Based on the map, field work performed a ground truth map was prepared. The ground truth map was used in order to evaluate the accuracy of classification. The images analysis involved three basic steps in supervised classification: the training stage, the classification stage and the output stage. Training stage was needed for supervised classification. In the training stage we used plots information that collected in field surveys. In the classification stage, three supervised classification methods were selected to classify the digital data. Maximum Likelihood, Minimum Distance-to-Means and Parallelepiped classifiers were applied in this stage. In the output stage, the classified maps which are thematic maps of vegetation cover types over Galoochar forest reservoir. Density classification was performed considering four density classes consisting of thin (0-25%), semi-dense (25-50%), dense (50-75%) and full dense (75-100%) coverage. Different methods for accuracy assessment have been discussed in remote sensing literatures. Kappa coefficient was used in this study. It is widely used because all elements in the classification error matrix, not just the main diagonal, contribute to its calculation and because it compensates for change agreement [16]. Kappa coefficients were generated to describe the proportion of agreement between the classification result and the validation sites after random agreements by chance are removed from consideration these data [17]. Also overall accuracy was used for accuracy assessment. Work steps of producing density maps, using IRS-P6, LISS III satellite data showed in a simple model (Figure 1).

RESULT

As said, three supervised classification methods were selected to classify the digital data which (Table 1) shows the relevant results. In thematic mapping using remotely sensed data, the term accuracy is used typically to express the degree of ‘correctness’ of a map

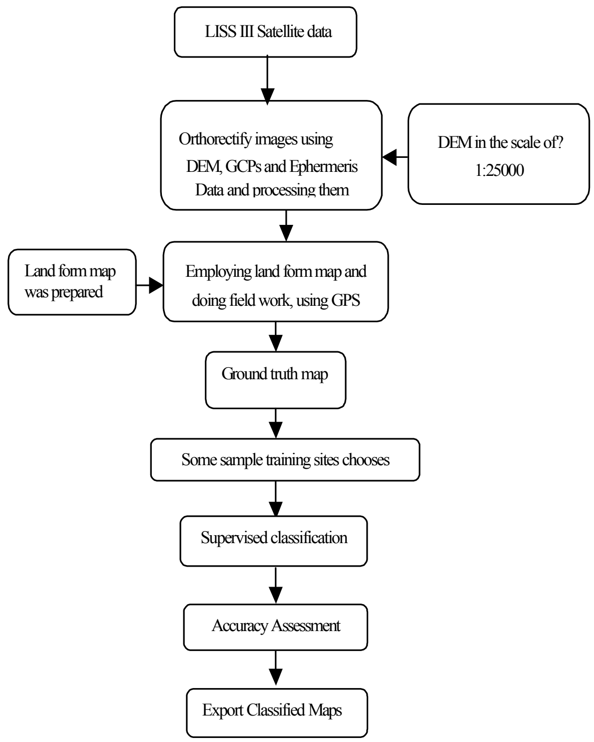

Fig. 1: Processes flow chart of the project

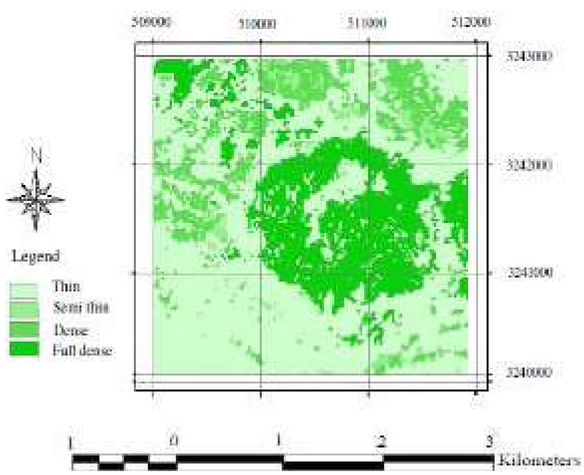

Fig. 2: The density map produced by ML classifier

or classification [18]. Producer and user accuracies showed the same good result in maximum likelihood (ML) classifier for density classification (Table 2). In this way, ML classifier presented the overall accuracy and kappa coefficient equal to 80.41 and 0.7251 respectively. Finally, the plant coverage density of Galoochar Juniper forest reservoir was classified by using Maximum Likelihood classifier. The classification result is shown in Figure 2.

Table 1: The result of Kappa coefficient and overall classification accuracy (%) in 3 classifiers for producing canopy density map by LISS III satellite data

Classification method	Kappa coefficient	Overall classification accuracy (%)
Maximum Likelihood	0.7957	81.79
Minimum Distance-to-Means	0.7251	80.41
Parallelepiped	0.6122	65.34

Table 2: The result of producer accuracies (%) and user accuracies (%) in 3 classifiers for producing canopy density map by LISS III satellite data

Classification method	Producer accuracies (%)	User accuracies (%)
Maximum Likelihood	84.13	81.19
Minimum Distance-to-Means	83.57	79.44
Parallelepiped	79.25	73.60

DISCUSSION

Various types of ecological experiments utilizing different types of satellite data. In a survey for producing map vegetation over Jornada used landsat TM, which the overall accuracy of the various products ranged from 60–70%, depending on which field data points were included [19]. Using single date imagery like LISS III saves time and costs related to data acquisition and processing and appears to generate satisfactory results in comparison of multi temporal data in a region if used a sufficient classifier [20]. Results of three classifiers that used in present study were compared by calculating correctness indicators for each of the three output maps (Table 1,2). By comparing the results of three classifiers, it is clear that ML classifier showed the best results (overall accuracy and kappa coefficient equal to 80.41 and 0.7251 respectively). Distinguished margin in the onset of canopy density classes help to differentiate among density classes [1] and lead to better result in classification. Reliable thematic maps can be produced inexpensively and rapidly with high accuracy if the selected data is acquired at the time of maximum phenological variation [20].

CONCLUSION

Monitoring of vegetation coverage in forests on a global scale is essential for understanding and predicting of dynamic and changes of these natural resources. Density map is very useful for following the changes in forests such as forestation and deforestation in big scale.

Finding a reliable method for investigating of these changes is very important for better management. In this research examined the ability of IRS-P6, LISS III data in distinguishing density classes by three classifiers in a forest. Based on the results, using LISS III data is appropriate for producing density coverage map by maximum likelihood classifier. In order to increase the classification accuracy, using the other classification methods like object-based method, using different indexes and also multitemporal data [21-23] are suggestible.

ACKNOWLEDGMENT

We would like to express our appreciation to Mr. abdolhossein zangiabadi and Galoochar residents for their merciful and help.

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